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Virus Infections in Citrus Trees [1]

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A number of citrus infections are now known to occur in citrus trees. The more important are psorosis, tristeza, exocortis and xyloporosis. In the present paper these infections as well as the less important ones are reviewed.

Effect of Virus Infections on Citrus Trees

It is interesting that virus infections are largely latent in orchard trees without appearing to harm them, but all are capable under special circumstances of causing damaging diseases. The sweet orange and its many varieties have a high degree of tolerance to all the infections except psorosis. Grapefruits are tolerant to exocortis and xyloporosis, sensitive to psorosis, and moderately sensitive to tristeza. Some of the mandarins and their hybrids are sensitive to xyloporosis and psorosis but tolerant to the others. Less information is available on the behavior of lemons (Eureka and Lisbon), which seem to have tolerance to all of them.

Some diseases produced in citrus trees are due directly to the sensitivity of the scion. Psorosis in sweet orange and grapefruit, cachexia in the Orlando tangelo, and virus dieback in sour lime may be cited as samples. Other diseases are due to the sensitivity of the rootstock. There are many examples of these: tristeza in trees of sweet orange, mandarin and grapefruit on roots of sour orange; exocortis in trees on rootstocks of trifoliate orange, some citranges, and the rangpur lime; and xyloporosis in trees on stocks of sweet lime, some varieties of mandarins and mandarin hybrids. In the second group the causal virus is carried by the scion variety. While the variety is on its own roots or on the roots of another tolerant species the infection remains latent in the tree. But once the scion is put on a sensitive stock the tree develops symptoms and reveals the presence of virus infection. A sweet orange scion infected with tristeza virus grows well on stocks like rough lemon, sweet orange, and rangpur lime, but if budded on sour orange the scion fails to grow and never develops a tree. A scion infected with xyloporosis grows well on the sour orange but poorly on sweet lime. Trouble with virus infections in citrus trees follows largely from the practice of forming trees from two different species. A common symptom of the composite tree is a degeneration of the vascular tissue at or just below the bud union. This causes girdling of the tree and induces a type of incompatibility between the species. The best place to look for the harmful effects of virus infections is in a rootstock experiment, where the failures of trees on some stocks is due mostly to viruses latent in the scion varieties.

Some anomalies are to be found in the behavior of citrus trees to virus infection. Trees of sweet orange on sour roots are seriously injured by tristeza because of the sensitivity of sour orange. Yet seedlings of sour orange can be grown successfully on their own roots or on the roots of other species even though they pick up tristeza naturally. And infected scions of Eureka and Lisbon lemons can be grown on sour roots and will develop into sizable trees. Work

[1] This paper forms part of a report by the writer following his visit during 1956 to Ghana, Brazil, United States (Florida, Texas and California) and Israel, to see the work being done in these countries on virus diseases of citrus.

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in South Africa (19, 20) and Australia (16) suggests that tristeza virus is a complex which varies qualitatively in different species of citrus, and that different species when exposed to natural infection are selective and pick up only that part of the complex to which the species is reasonably tolerant. Further, it has been demonstrated that the virus normally present in a sweet orange when introduced by a graft into a sour orange seedling does far more damage to the seedling than virus from naturally infected trees of either sour orange or lemon. In a composite tree to which infection is brought by aphids the scion picks up the infection and not the rootstock. So when the tree is a sweet orange on a sour root the tree breaks down from tristeza because the infection picked up by the sweet orange scion, although tolerated by the sweet orange itself, is very harmful to the stock. When either the whole tree or the scion is sour orange, the sour orange picks up the infection and what it picks up is something to which it is fairly tolerant, so the tree will survive. When the tree is a lemon on sour orange the tree will also survive because what the lemon picks up can also be tolerated by the sour orange.

In some experimental orchards in Israel trees of sweet orange on sweet lime roots seem to suffer more injury from xyloporosis than seedling trees of sweet lime on their own roots and some trees with sweet lime as the scion on the roots of sour orange and other tolerant species. But further observations are needed to confirm whether this is true.

Distribution of Citrus Viruses in the World

The main viruses of citrus are not confined to any country but are world-wide in distribution. And this is not surprising because in the past budwood was freely exchanged between countries. At most centers of citrus research is a collection of species and varieties from different parts of the world and probably a collection of most, if not all the citrus viruses as well. In its beginning citrus pathology was concerned with the more obvious diseases, like bacterial canker, gummosis, foot rot and so on. Virus infections were unknown. An outwardly healthy appearance was sufficient for new introductions to be released from quarantine. As the virus infections for the most part are carried latently in many citrus species, it is not surprising that they passed unnoticed through the quarantine barriers of all countries. In more recent years restrictions on the importations of citrus in many countries have been tightened. Some have even gone to the extreme of imposing a complete ban on new introductions or allowing the entry of importations that pass the test of an elaborate series of indexing (36). But the door was open so long that it will be surprising if any viruses remain to be introduced.

Occurrence and Spread of Virus Infections in Commercial Varieties

The main virus infections are now known to occur in most commercial varieties. They may be present singly but often two or more are found together in the same tree. Tristeza is the only one known to have a vector, and in countries where both virus and its principal vector are present together the virus becomes general in all orchard trees. The other viruses, with no known vectors, spread slowly if they spread at all. They are graft-transmissible and perpetuated in the clonal progeny of diseased trees. The nursery is perhaps their main point of distribution. If no precautions are taken it is possible for large numbers of infected trees to be planted in the orchard and the number of infections will eventually mount to an imposing total. Without a vector it is ordinarily difficult, if not impossible, for a virus to spread in the orchard. It can happen by way of root graft between two trees growing in close proximity. But it can happen more easily in the course of certain practices in the orchard and nursery. When a grower cuts back trees of one variety and then topworks the stumps to another variety, infection in the original tree will be transmitted to the second variety. And fresh contaminations of varieties must have occurred often in the nursery when rootstocks have been rebudded because of the earlier buds remaining dormant or for some other reason. Recent evidence from Florida suggests that xyloporosis

may be transmitted through the seed (4). If this is true xyloporosis can spread from one clone to another through infection in rootstock seedlings. The other viruses are not known to be seed-transmissible.

Over the years psorosis, exocortis, and xyloporosis have been accumulating in many citrus clones. In Florida where many orchard trees have been tested, the conclusion is that xyloporosis virus is present in the majority of her sweet oranges and in many of her grapefruits as well (6). The same is true in Israel and probably in all countries growing citrus. The high incidence of xyloporosis in sweet oranges and grapefruits in some countries suggests that the virus is being spread by means other than grafting, and the infection could well be coming into fresh trees by way of rootstock seedlings. But in some cases the high incidence of infection in a clonal population may simply mean that an infected parent was the starting point.

Exocortis is also common in some clones of sweet orange, grapefruit and lemon and probably occurs alongside xyloporosis in many trees. In Brazil, where the sensitive rangpur lime is a stock, exocortis is known to occur in many of her sweet oranges, and all trees within the old clone of Bahianinha navel are said to be infected (21, 31). In Australia, where trifoliate orange is one of the rootstocks, many sweet oranges, grapefruits and lemons have been found to carry exocortis (1). Wherever rootstock experiments are run there is evidence of exocortis and xyloporosis in the local varieties.

The most common disease of all in old orchards of sweet oranges and grapefruit is psorosis and it is the main cause of old trees going out of production. Some countries state that it causes greater losses than any other disease. This is true in Mediterranean countries, in California and in Texas. Psorosis was the first of the citrus viruses to be discovered and has been known since 1896. If its severe effects were produced immediately the disease would have been eliminated years ago. But the infection remains latent in young trees and only produces symptoms when trees are older. This is one reason why infected parents have been used in the past for propagation, and why the virus is more widespread than it should be in older orchards.

Control

The control of virus infections in citrus, as in other fruit trees, depends on how the virus spreads and its rate of spread. With a virus like tristeza nothing can be done to eradicate the virus when it gains a foothold in a country possessing an insect vector. Such factors as spread of infection by the vector, the perpetuation of infection in the clonal progeny of infected parents, and the fact that the host is a tree with a semi-permanent place in the field mean that the virus will become general in orchard trees. This is actually the case in South America, South Africa and Australia. In these countries citrus trees must live with tristeza and, as experience has shown, this can be done successfully with some species, provided they are put on tolerant rootstocks. Scion species like sweet orange, tangerine and lemon mostly have good tolerance. Grapefruit and sour lime are more sensitive species and more difficult to grow successfully.

The other virus infections like psorosis, exocortis, and xyloporosis have no vector, as far as is known. They spread slowly if they spread at all, from tree to tree, and for this reason they can be controlled by propagating from healthy parent trees. The three viruses are carried latently in many scion varieties, and infected scions can be grown successfully on the roots of tolerant species. But they cause harmful diseases when either scion or stock is sensitive. The control of diseases like psorosis in sweet orange, cachexia of Orlando tangelo, or scaly butt of trees on trifoliate stock, depends on propagating from healthy trees. Psorosis and exocortis are not known to be transmitted through seed, therefore the source of the seed from which the rootstocks are raised is not important to them. But the use of healthy seed for raising rootstocks may have to be an additional precaution against xyloporosis.

Trees injured by exocortis or xyloporosis because of a sensitive rootstock can be improved and their vigor restored by inarching them to a tolerant stock. This is the method used in Israel to control xyloporosis. Citrus scions in most areas of Israel are started on sweet lime stock, but because the scions are mostly infected with xyloporosis, the

trees have to be inarched to the tolerant sour orange within a few years.

The seriousness of psorosis has forced many countries to take more active steps to control the disease in new orchards by encouraging nurserymen to propagate from trees that have been inspected and certified free of the disease. In some countries the scheme is voluntary, and nurserymen may choose for themselves whether or not they propagate from certified trees; in others the scheme is compulsory.

The citrus industry of Florida has gone a step further in its "budwood" program and demands complete freedom of the tree from all known virus infections and trueness to type before the tree is registered (22). This is an outstanding project from which eventually valuable sources of healthy material may be unearthed from amongst the mass of infected trees. The scheme was started in 1953.

An increasing interest is being shown in nucellar seedlings as a means of re-establishing the old commercial clones and freeing them from virus infections. With the possible exception of xyloporosis the viruses found in citrus are apparently not transmitted through the seed. Nucellar seedlings possess excellent vigor and usually outgrow trees of the parent clones. Objection to the immediate use of a nucellar seedling as an orchard tree is raised on the grounds of thorniness, slowness in coming into bearing, poorness in cropping in the early years, and the uncertainty of its ultimate performance from a commercial standpoint. In the beginning the nucellar seedling expends most energy on vegetative growth and until this vegetative vigor slows down and the tree begins to produce better crops of fruit the seedling is considered unsafe for commercial propagation. A start has been made in propagating commercially some of the new nucellar clones. The better-known nucellar selections are those of Frost in California. But there are many others.

Economic Importance

The most spectacular destruction of citrus trees from a virus infection occurred when tristeza virus spread through the orchards of South America and killed many millions of trees on the rootstock of sour orange (7). In California, where the virus has a slower rate of spread, the figure given for trees on sour orange destroyed is 300,000 (33). In South Africa and Australia tristeza is a cause of many grapefruits declining prematurely; and in West Africa it is a limiting factor in the growing of the small sour lime.

But in most countries psorosis is the important disease and accounts for more trees going out of production than any other cause. Affected trees decline slowly, and each year more and more of them cease to be profitable.

Xyloporosis is a problem in Florida in the growing of the Orlando tangelo (2). In early plantings many trees were dwarfed and unproductive because of the infection and had to be replaced. In Israel xyloporosis limits the usefulness of the sweet lime as a rootstock and necessitates the subsequent inarching of affected trees to sour orange (29).

In Australia many trees on trifoliate stock have been dwarfed and made unproductive by exocortis (1). What appears to be the same virus disease is reported from Brazil as a problem in trees on rangpur lime stock (21, 31).

The above examples illustrate the destructive effects of the citrus viruses. Of the many millions of citrus trees throughout the world the percentage that is free of infection is undoubtedly small. Most trees probably carry one or more viruses without signs of harm. In fact it is for this reason that the viruses are so widespread in citrus trees. A beneficial virus has yet to be found and one must assume that infections present in a tree do not help it. The reason why nucellars grow better than trees of the parent clone may be due largely to the absence of virus infection.

In spite of the many ways in which the health of citrus trees can be undermined and despite the accumulation of virus infection in citrus trees, the citrus industries in the different parts of the world continue to run profitably. Trees which are well cared for and on suitable stocks normally grow well and yield good crops. From the useful information accumulated in recent years the circumstances which make the main virus infections injurious to the tree are now

known and, subsequently, many of the difficulties can be avoided.

Psorosis

A number of different strains of psorosis have been identified in California and called respectively psorosis A, psorosis B, blind pocket, concave gum, crinkly leaf, and infectious variegation (12, 35). The common strain and the important one in the orchard is psorosis A which produces the typical symptoms of scaly bark. It can infect many species of citrus but only produces bark scaling in some species like the sweet orange, grapefruit and tangerine. In fact psorosis is mainly a disease of sweet oranges, grapefruits and tangerines. Other species like the lemon and sour orange do not show bark scaling. Crinkly leaf and infectious variegation are strains that occur in lemons. The different strains have in common a distinctive type of leaf symptom, which develops in young immature leaves.

Psorosis is bud-transmissible, but is not transmitted through the seed, nor has the virus any known insect vector. In consequence the disease apparently does not spread naturally in the field.

Of the virus diseases of citrus psorosis has been known the longest and was first described from Florida in 1896 by SWINGLE and WEBBER (32). In most citrus areas of the world more citrus trees go out of production from psorosis than from any other disease. It is the main disease in California and Texas and one of the more important in Florida. In the Mediterranean areas and especially in Spain it is a serious problem. In Israel the main commercial variety, Shamouti, is comparatively free of infection, but 40 percent of the Valencias and 20 percent of the grapefruits are said to show visible signs of the disease.

South Africa is one country in which psorosis today is of minor importance largely because of control measures taken 30 years ago. The disease was first reported in 1918, and in 1927 the destruction of diseased trees was made compulsory. In the first 11 years, 7 million trees were inspected and 8,500 diseased trees were discovered and destroyed. Today psorosis is rare in South African orchards.

The nursery is the distributing center of psorosis. No vector is known, and the disease is perpetuated in the clonal progeny of infected parents. To control the disease in new orchards many countries now have a service to inspect parent trees, and trees that pass the test are registered as free of psorosis. In Israel nurserymen are compelled to propagate from certified parent trees, but in most other countries nurserymen decide for themselves what to do.

A problem in the control of psorosis is that the infection remains latent in young trees, and the conspicuous symptom of barkscaling develops only after trees have grown up and are 10 to 15 years old. But during flushes of growth young immature leaves may show chlorotic markings that are said to be diagnostic for psorosis: this "immature leaf" symptom is only temporary and not conspicuous, and not always a reliable guide.

Tristeza

Tristeza is the name of the causal virus of such diseases as tristeza (Brazil), quick decline (California), stem-pitting (South Africa), and lime dieback (Ghana). The virus causes a serious disease in citrus trees on the roots of sour orange and especially in trees of sweet orange, tangerine and grapefruit on this stock. It is impossible to develop trees of this combination of stock and scion from infected parents. If trees become infected after full development they decline rapidly and may die. Tristeza may also cause a serious decline, accompanied by dieback in seedling trees of the West Indian lime. When trees of grapefruit are infected they develop stem-pitting disease and irrespective of the stock may decline prematurely.

The small sour lime (known as West Indian, Key, or Mexican lime) has become the standard indicator for the virus. It reacts with a distinctive leaf symptom and with pit-like lesions in the wood. The lesions are often long and narrow and resemble grooves more than pits.

Many species of citrus are tolerant to tristeza and either carry the infection latently or show symptoms like those of the sour lime. Tristeza appears to exist as a complex of strains in many orchard trees,

the complex varying in individual trees and especially in trees of different species.

The virus is bud-transmissible but is not transmitted through the seed. Three aphid vectors are known: *Toxoptera citricidus* (= *Aphis citricidus*) (10), *Aphis gossypii* and *A. spiraecola*. Only the first one is an efficient vector. The other two are reported to transmit the virus only occasionally.

Tristeza is one of the most widespread of the citrus viruses. In countries where both virus and its principal insect vector *Toxoptera citricidus* occur together, the virus is general in orchard trees. This is the case in South Africa, South America, Australia and probably in many of the citrus areas of the Far East as well. Many citrus species like sweet orange, tangerine and lemon possess good tolerance and can be grown successfully with tristeza infection, provided trees are on tolerant stocks like the rough lemon, sweet orange and rangpur lime. Some species like sour lime and grapefruit are more sensitive and may suffer injury and premature decline even when grown on tolerant roots. But the most sensitive trees to tristeza virus are sweet orange and tangerine trees on sour orange. The outbreak of tristeza disease in South America between 1930-40 in trees on sour roots resulted in the greatest destruction of citrus trees in a single epidemic from a virus infection. The industries in South America have now been restored by growing trees on tolerant stocks. Tristeza has also destroyed many trees on sour stock in California and Florida. But the virus spreads more slowly in these places than it did in South America. The reason is a difference in vectors and a difference in their transmitting powers. The principal vector, *T. citricidus* does not occur in North America, but two other species, *Aphis gossypii* and *A. spiraecola* which colonize citrus, have been shown experimentally to be inefficient vectors (9, 23).

The position in Texas is interesting. Here most trees are on sour roots and vulnerable to tristeza. It is known now that tristeza was brought into the citrus areas of Texas in various importations, including Meyer lemon, and some varieties of Satsuma and mandarin, during the past 30 years (25). In this period the virus has apparently remained confined to the clonal progeny of these introductions, and there is no evidence of spread to other trees, even though *Aphis gossypii* and *A. spiraecola* occur on citrus trees in Texas. And attempts to transmit infection from Meyer lemons to other citrus varieties by the two species of *Aphis* have consistently failed (8). In Israel, where tristeza was discovered recently, there is no evidence that the virus spread to other trees (30). In a period of 25 years the virus has remained confined to the clonal progeny of certain imported varieties in which it was introduced. The only insect in the Mediterranean area known to be a vector of tristeza, and a decidedly poor one, is *A. gossypii*. The other species of aphid common on citrus in Israel is *Toxoptera aurantii*, and it is apparently unable to transmit tristeza virus.

Therefore, tristeza can be unimportant even in countries where citrus is mainly on sour roots, if unaccompanied by a vector.

Writers have speculated on what factor started the epidemic of tristeza in South America (36). On the assumption that *Toxoptera citricidus* is indigenous to South America, they believe it was the virus present in a large consignment of citrus trees shipped from South Africa in 1930 and 1931. But the crucial factor may have been not so much the virus present in the trees but the introduction with the trees of the vector itself. The total number of introduced trees is given as 2,600. Unless special precautions were taken, aphid colonies on shoots of the trees could easily have passed the barrier. There must have been importations of citrus into South America earlier than 1930, and it would be strange if all these importations had been free of tristeza.

Exocortis

Exocortis was originally described from California (14). Scaly butt of Australia (1) and " rangpur lime " exocortis of Brazil (31) and Texas (27) are probably diseases caused by the same virus.

Exocortis is best defined as a disease of citrus trees on certain rootstocks like *Poncirus trifoliata*, some citranges (trifoliate hybrids) and the rangpur lime. Affected trees show bark scaling on the stock portion of the trunk and stunted growth. Many species of citrus carry the virus latently

and the harmful effects show up only when infected scions are put on the roots of sensitive stocks.

The virus is bud-transmissible but apparently is not transmitted through the seed. No vector of the virus is known.

Exocortis will be found to occur in most countries and is probably common in trees of some commercial varieties. For the most part the infection remains latent because trees are on tolerant stocks. But it is of importance in Australia where the trifoliate orange has been used as a stock to a limited extent for many years (1). It is also a problem in Brazil in trees on rangpur lime, the main rootstock of the country, since tristeza prohibited the use of sour stock (21, 31). The only solution to the problem of growing trees on stocks like trifoliate orange and rangpur lime is to propagate from parents known to be free of exocortis.

Xyloporosis (Cachexia)

Xyloporosis and cachexia are diseases now considered to be caused by the same virus (4, 5). Xyloporosis was originally described from Palestine as a disease of citrus trees on sweet lime stock (29), and cachexia from Florida as a disease of the Orlando tangelo (2). Observations in Florida and Texas show that the varieties most sensitive to the virus are to be found amongst the mandarins, mandarin hybrids (tangelos), kumquats and kumquat hybrids (3, 24). The virus causes a degeneration of xylem and phloem with the development of peg-like outgrowths from the inner face of the bark that fit into corresponding pit-like depressions in the wood. (This symptom is similar to the pitting of tristeza, but the pits of tristeza are often long and narrow and more like grooves or channels than pits.) Gum pockets develop in the bark and the phloem becomes discolored in many sensitive varieties. In Florida many orchard trees of sweet orange on rough-lemon show at the union a groove round the wood with a ridge from the cambial face of the bark fitting into it (17). This "bud-union" abnormality and a similar one described from Israel in trees of Shamouti orange on rough lemon (28) are considered to be caused by xyloporosis.

The severity of xyloporosis on the tree as a whole varies and depends largely on the composition of the tree. In general when one component of the tree is a sensitive variety, whether it be rootstock or scion, then the tree becomes stunted and declines prematurely. Many varieties of citrus, including most sweet oranges and grapefruits, possess good tolerance and, apart from mild pitting that develops in some of them, are apparently unharmed when infected and grow well, provided they are on their own roots or on the roots of a tolerant stock.

The virus is bud-transmissible. In Florida there is evidence that it is transmitted through the seed of some species but this requires confirmation (4). Observations in Israel also suggest that it may be seed-transmitted. No insect vector is known.

Xyloporosis is another virus that probably occurs in most citrus areas of the world, and seems to have become plentiful in clones of many citrus varieties. Some observers in Israel believe that most citrus trees there now carry the infection. And in Florida where many orchard trees have been indexed, xyloporosis has been found to be fairly general in sweet oranges and grapefruits (6). The same is true in Texas (26) and probably in most other citrus countries as well.

It is difficult to assess the economic importance of xyloporosis. Although widespread and probably general in many varieties the virus seems to do little harm to most trees.

In Florida the disease is of importance only in the Orlando tangelo, which is grown there on a small scale. In the beginning, when no precaution was taken, some plantings of Orlando tangelo showed anything from 1 to 60 percent of diseased trees; and diseased trees of this variety are poor and unproductive, and have to be replaced. But budwood is now selected from parents known to be free of infection.

In Israel xyloporosis is a "rootstock" problem. Most scion varieties seem to carry the infection. In spite of its sensitivity to xyloporosis the sweet lime is still used as a rootstock for sandy soils, and the practice remains of starting trees on this stock. Permanent injury from xyloporosis is pre-

vented by subsequently inarching the trees to sour orange. In effect, this practice puts the trees on tolerant roots. In recent plantings of Shamouti orange the inarching is being done within three to five years of planting. Citrus trees in Israel are mainly vigorous and productive. Therefore, the infection probably does no more damage there to species like sweet oranges and grapefruits than in any other part of the world. It does no more than restrict the usefulness of sweet lime as a stock and adds slightly to the cost of maintenance in the orchard by the need of inarching. Nevertheless, as was pointed out by CHILDS (5), it is desirable to find and propagate xyloporosis-free strains of Shamouti and other commercial varieties. Only in this way can the sweet lime as a rootstock be used to the greatest advantage.

Vein Enation Virus

Vein enation virus has been found in many citrus trees both in California (34) and South Africa (18). Its occurrence in Australia is also reported. The infection appears to do no harm and no circumstances are known whereby it can cause a serious disease. The typical symptoms are small swellings and enations that develop on the veins on the lower surface of the leaves. Seedlings of a number of species when infected artificially have been known to grow as well as healthy controls.

The virus is bud-transmissible. In South Africa it has been transmitted by *Toxoptera citricidus*.

Stubborn Disease

Stubborn is a disease of Washington Navel and grapefruit and is reported only from parts of California and Arizona (11, 13, 15). Affected trees lack vigor and are unproductive; their leaves are smaller and more upright and their buds are often multiple. The fruits of affected navels are sometimes acorn-shaped, and the rind of such fruits at the stylar end is often pinkish and hence the other common name of pink-nose.

The disease is transmissible by grafts. There is no evidence that it spreads naturally in the field.

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CORRIGENDUM

On page 129, Volume V, No. 8 of this *Bulletin*, the title of the article by I. Reichert and A. Bental should read:

"Additional Tristeza-infected Citrus Varieties Found in Israel."

A Virus Disease of Sweet Cherry in Italy

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A new disorder of sweet cherry (*Prunus avium*) was observed in the Province of Modena in northern Italy during June 1956, affecting two varieties, Durona nera and Durona della Marca. Examination of the affected trees and their distribution led to the belief that the disorder is not of parasitic origin nor due to nutrient deficiency. Preliminary experiments on its transmission appear to indicate that it is a virus disease.

Symptoms

The main symptoms of the disease include reduced growth of buds, withering of branches and production of smaller leaves or formation of leaves in tufts (Figure 1). Many leaves show chlorotic spots, curling, shot holes and laceration (Figure 2). The shot holes are usually irregularly distributed but sometimes they are located along the veins. In a few cases red discoloration of the veins in the lower half of the leaf and necrosis of the leaf tip have been observed.

Transmission

Preliminary experiments to transmit the disease by grafting have been carried out. When buds from the diseased sweet cherry tree were grafted on healthy seedlings of the variety Shiro-fugen of oriental flowering cherry (*Prunus serrulata*), gum and necrosis were produced near the buds. The variety Kwanzan of oriental flowering cherry, when budded with diseased buds, also reacted similarly, showing gummosis and bark canker. On the other hand, such reactions were not observed on trees of sweet cherry, sour cherry (*Prunus cerasus*), plum (*P. domestica*), peach (*P. persica*) and blackthorn (*P. spinosa*), which were budded with diseased buds.

When buds from virus-free trees of Shiro-fugen oriental flowering cherry were budded on diseased sweet cherry trees, the buds commonly died and gum and tissue

Figure 1. A branch from a diseased sweet cherry tree showing tufty curled leaves.

necrosis (Figure 3) appeared adjacent to the diseased bud shields. Such buds, when budded on healthy sweet cherry trees, grew normally.

Gum excretion was also observed when healthy Kwanzan buds were budded on diseased sweet cherry trees, but was never seen when buds of the plum variety Burbank were used.

Apparently the two varieties of oriental flowering cherry, Shiro-fugen and Kwanzan, are particularly sensitive to the disease and may be used as indicators.

Among the early results obtained in the spring of 1957 from the transmission experiments, symptoms on plum were evident. On the Burbank plum trees budded with diseased sweet cherry buds, branches with deformed leaves were produced near the point of bud insertion. Some leaves were narrow or nearly filiform and others showed downward rolling of edges or downward rolling of leaf tips due to the scarce growth of midribs. Many leaves had chlorosis of veins and adjacent areas, the chlorosis being more extensive toward the top part of the leaf (Figure 4), resulting in a recticular pattern which appears to be similar to that produced by the virus of Shiro plum recently reported in Italy by Capretti.[1] These symptoms are also similar to those caused by the rasp leaf virus on sweet cherry described by Ronde Kristensen in Denmark.[2]

The symptoms mentioned above occurred on branches within a distance of one meter from the point of bud insertion, but they were not found at the time of observation on the branches further away.

Figure 3. Sections of branches of diseased sweet cherry trees on which healthy buds of Kwanzan (left) and Shiro-fugen (right), oriental flowering cherries, were budded, showing brown discoloration of tissues adjacent to the Shiro-fugen bud shield.

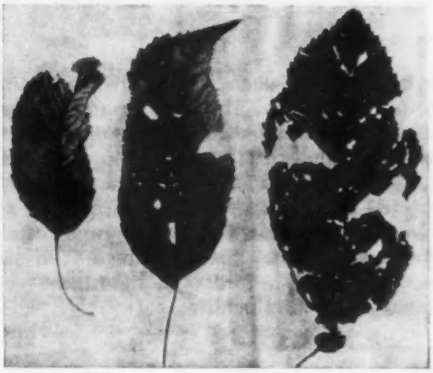

Figure 2. Leaves from diseased sweet cherry tree showing chlorosis, shot holes and laceration.

Discussions

Observations and preliminary transmission experiments carried out so far indicate that

[1] CAPRETTI, C. 1954. Alterazioni di probabile natura virosica nel susino e nel cotogno. *Rivista Ortoflorofrutticoltura Ital. 38* : 442-446.

[2] RØNDE KRISTENSEN, H. 1956. Virussygdomme hos Stenfrugttræer. *Tidsskr. Planteavl 60:* 69-166.

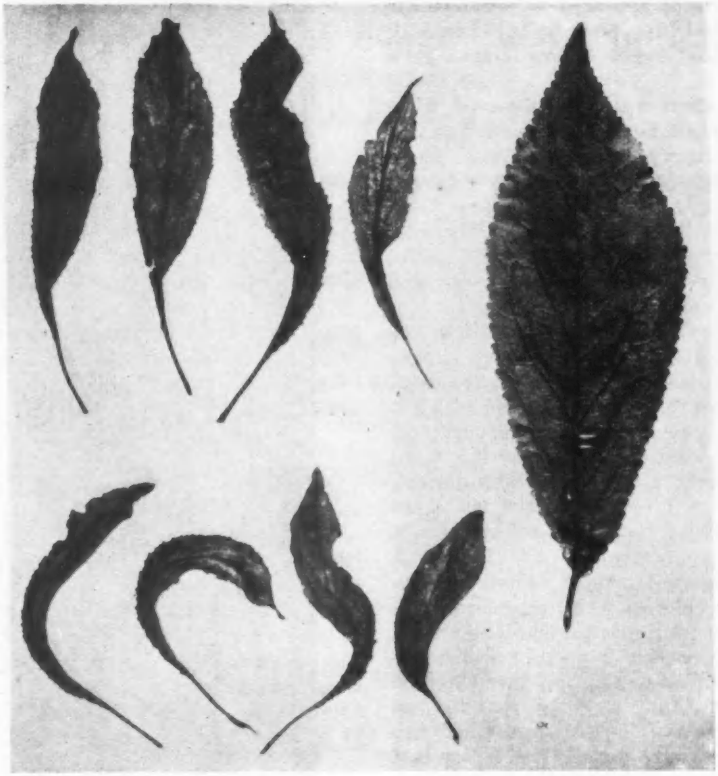

Figure 4. Deformation of leaves produced on branch of Burbank plum budded with diseased sweet cherry buds, showing leaf rolling and vein chlorosis. A normal leaf at right.

this disease of sweet cherry, hitherto unrecorded in Italy, is of virus origin, similar to ring spot of stone fruits described from North America. [3] It is probable that a mixture of viruses or virus strains is involved and that under certain conditions the virus or virus complex may produce symptoms on susceptible hosts when it is in association with other factors, such as has been demonstrated in Pfeffinger disease of sweet cherry and other virus diseases.

The effect of this disease on fruit production has not been established, because the yield of sweet cherries in 1956 was in general very low due to the extremely severe winter. Nor is it known when and where the initial infection took place. It can be assumed, however, that in the affected area there are trees infected by the virus but they do not show symptoms. The orchards of the area will be inspected and growers will be warned not to use buds from diseased trees for propagation. Experiments on the disease transmission are being continued in order to determine the characteristics of the disease.

[3] COCHRAN, L.C. *et al.* 1951. Ring spot in virus diseases and other disorders with viruslike symptoms of stone fruits in North America. U.S. Dept. Agr. *Agriculture Handbook 10* : 71-80.

Outbreaks and New Records

Andaman Islands (India)

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Occurrence of the Perithecial Stage of Sugar Cane Red Rot Fungus

A survey of plant diseases was carried out recently by the author, on Andaman Islands situated in the eastern part of the Bay of Bengal. The main crops on the Islands are rice and coconut, and several other crops are grown in small areas, mainly as kitchen garden crops.

Sugar cane is not raised as a regular crop and only a small plot grown in a demonstration farm, consisting of a few rows each of a number of introduced varieties, was available for examination. In this plot, midrib infection with acervuli of *Colletotrichum falcatum* was observed on leaves of the following varieties: Co. 419, Co. 449, Co. 467, Co. 475 and Co. 683 which were introduced in 1951, and Co. 421 introduced in 1953. In addition to acervuli, the perithecial stage of the fungus, *Physalospora tucumanensis*, was found on mature leaves of sugar cane plants. It was reported that a fairly severe red rot outbreak appeared on the Islands in 1955 when sugar cane was grown over an area of about 100 acres. It seems that climatic conditions there are favorable for the development of the perithecial stage of the fungus.

The occurrence in nature of the perithecial stage of *Colletotrichum falcatum* was first recorded in Louisiana [1] and then in Formosa. [2] In India, perithecia of this fungus were found on dried old leaves in an 18-month old sugar cane crop in New Delhi in 1953. [3]

[1] CARVAJAL, F. and C.W. EDGERTON. 1944. The perfect stage of *Colletotrichum falcatum*. *Phytopath. 34*: 206-213.

[2] LING, K.C. and P.T. MA. 1950. The perfect stage of causal organism of red rot of sugar cane. *Jour. Sugar Research 4*: 1-20.

[3] CHONA, B.L. and B.S. BAJAJ. 1953. Occurrence in nature of *Physalospora tucumanensis* Speg., the perfect stage of sugar cane red rot organism in India. *Indian Phytopath. 6*: 63-65.

Italy

Plant Protection Service, Ministry of Agriculture, Rome

New Plant Diseases Found in 1956

SMALL nodular galls were observed on stems of the ornamental plant babysbreath (*Gypsophila paniculata*) cultivated in the floricultural area of Tuscany. The galls were similar in appearance to those described by BROWN [1] from the United States. The bacterial pathogene, *Agrobacterium gypsophilae* (Brown) Starr *et al*, was isolated and identified.

[1] BROWN, N.A. 1934. A gall similar to crown gall produced on *Gypsophila* by a new bacterium. *Jour. Agr. Res. 48*: 1099-1112.

Ustilago raciborskiana Siemaszko & Wroblewski was found to attack the ornamental plant *Polygonum baldschuanicum* in the province of Verona in northeastern Italy, destroying nearly all the flowers of the affected plants. The host is a close relative of *P. auberti*, on which the fungus was originally described.

Tomato plants grown in greenhouses in the province of Pisa were infected by a virus disease, the symptoms of which were entirely different from those hitherto observed on tomatoes in other areas of the country. It is probably caused by the typical tobacco-mosaic virus or *Nicotiana* virus 1.

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United States

Plant Pest Control Branch
Agricultural Research Service
United States Department of Agriculture

Further Spread of Spotted Alfalfa Aphid

THE spotted alfalfa aphid (*Pterocallidium* sp.) was first reported in the United States in the spring of 1954 from New Mexico. By the end of 1955 this destructive pest had reached the Mississippi River and in early 1956 it was collected in northern Florida. As of 1 January 1957, the aphid was known to be present in 30 states. It has been said that it had shown the greatest rate of spread of any pest ever introduced into the United States. Limited observations on biology and habits of the species in different areas of the United States indicate that mild winters and wind seem to favor development and spread of infestations. The greatest damage in 1956 occurred in the spring and autumn. Estimates received from the more heavily infested states show that alfalfa losses attributable to this pest amounted to nearly U.S. $ 42,000,000 in 1956 as compared to approximately $ 34,400,000 in 1955 and about $ 5,000,000 in 1954. While loss from spotted alfalfa aphid has been heavy, progress in chemical and biological control as well as in the development of resistant alfalfa varieties has been encouraging.

Plant Quarantine Announcements

Switzerland

Order No. 1 of 22 October 1956, published in the *Recueil des Lois fédérales* No. 53, 12 December 1956, established measures to be taken at the frontier for the protection of forests. For the purpose of the Order, the following genera are considered to be forest trees:

CONIFERS

Abies	*Picea*
Chamaecyparis	*Pinus*
Larix	*Pseudotsuga*

DECIDUOUS TREES

Acer	*Ostrya*
Alnus	*Populus*
Betula	*Prunus*
Carpinus	*Quercus*
Castanea	*Robinia*
Corylus	*Salix*
Fagus	*Sorbus*
Fraxinus	*Tilia*
Juglans	*Ulmus*

The pathogenes and pests, the import and transit of which is prohibited, are *Endoconidiophora fagacearum*= *Chalara quercina* (oak wilt); *Endothia parasitica* (chestnut blight); *Xylosandrus germanus* (alnus bark beetle); *Hyphantria cunea* (fall webworm).

The importation of the plant materials enumerated below is prohibited.

a) living forest plants of all species, including seedlings, and twigs and cuttings of forest trees from non-European countries except the tropics;

b) fresh or dried leaves of forest plants, including those of mulberry, from any country.

The importation of the plant materials listed below must be accompanied by a phytosanitary certificate, similar to the model certificate annexed to the International Plant Protection Convention of 1951, issued by the country of origin in duplicate. Additional declarations are required wherever specified. In special cases an official statement indicating that the consignment originates from a non-infected region may be accepted in lieu of a certificate.

a) seeds and fruit of forest trees from non-European countries except the tropics. Additional declaration indicates freedom

from *Endoconidiophora fagacearum* and *Endothia parasitica* in the region of origin;

b) firewood and raw non-impregnated timber of broadleaved trees. If originating from the Federal Republic of Germany, France, United States, Canada and East Asia (Japan, Korea, China, Formosa), with or without bark, additional declaration should indicate freedom from *Xylosandrus germanus* in the consignment. If with bark, originating from Bulgaria, Yougoslavia, Austria, Rumania, Czechoslovakia and Hungary, additional declaration should indicate freedom from *Hyphantria cunea* in the consignment;

c) oak railway ties with bark from non-European countries. Additional declaration should indicate freedom of *Xylosandrus germanus* in the consignment.

The importation of living chestnut plants (including seedlings), twigs and cuttings, and firewood and raw non-impregnated timber (with or without bark) of chestnut is governed by the Federal Order of 26 September 1952 relative to the control of chestnut blight, which prohibits the importation of such materials except when authorized by the Division of Agriculture.

The importation of living plants, seedlings, twigs and cuttings of broadleaved trees not specified in the Order governed by the Federal Order of 1 June 1948 relative to the control of the San José scale, which requires consignments of all woody plants to be accompanied by phytosanitary certificates and fumigated at the point of entry.

The tropics, as defined in the Order, refer to Central America (excluding Mexico), South America (excluding Chile, Argentina, Uruguay), Africa (excluding Morocco, Algeria, Tunisia, Ghana, Libya, Egypt, Union of South Africa, Transvaal), and Asia (excluding West Pakistan and Kashmir) including Ceylon, Burma, Thailand, Viet-Nam, Indonesia and the Philippines.

United Kingdom (England and Wales)

The Importation of New Potatoes and Raw Vegetables (England and Wales) Order, 1957, which came into operation on 1 March 1957, repeats the 1956 Order under the same title (see *FAO Plant Prot. Bull.* **4** : 125-126. 1956), except that new potatoes grown in France, Portugal and Spain may be imported in 1957 from 1 March, and except for the item relating to cauliflowers from the Westland District and the Islands of the Province of South Holland, which has been omitted following information from the Netherlands authorities that those areas are now free from Colorado beetle.

News and Notes

Federal Republic of Germany Ratifies International Plant Protection Convention

The Government of the Federal Republic of Germany, whose representative signed the International Plant Protection Convention on 30 April 1952, deposited the instrument of ratification with the Director-General of FAO on 3 May 1957. The number of countries contracting to the Convention, including both signatory and adhering members, is thus, at the time of writing, 38, namely: Argentina, Australia, Austria, Belgium, Cambodia, Canada, Ceylon, Chile, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Federal Republic of Germany, Greece, Guatemala, India, Iraq, Ireland, Israel, Italy, Japan, Korea, Laos, Luxembourg, the Netherlands, New Zealand, Nicaragua, Norway, Pakistan, Republic of the Philippines, Portugal, Spain, Sweden, the Union of South Africa, the Union of Soviet Socialist Republics, the United Kingdom and Yugoslavia.

Symposium on Phytopharmacy

The ninth annual Symposium on Phytopharmacy was held at Ghent, Belgium, on 7 May 1957, under the sponsorship of the Belgian Institute of Agronomy. It was attended by scientists from Belgium, France, Germany, the United Kingdom and the Netherlands, as well as representatives of pesticide manufacturers.

The Symposium was opened by Prof. J. van den Brande, President of the Organizing Committee. Discussions on specific subjects were divided into five sections, with approximately 40 technical papers presented. Summaries of the papers will be published shortly and will be obtainable from the Organizing Committee, Institut agronomique de l'Etat, Coupure Links 233, Ghent.

Seed Potato Shipment from the Netherlands to Hungary

In order to assist the Government of Hungary to meet the shortage in seed supply for the 1957

spring sowing, FAO has urged its Member Governments to ship seeds of various crops to Hungary, and FAO and the International Committee of the Red Cross have assumed successively the responsibility for seed distribution within the country, with the co-operation of Hungarian authorities.

Among the governments responding to FAO's appeal, the Netherlands and Luxemburg shipped to Hungary about 2,500 tons of seed potatoes. The distribution of these seed potatoes was interrupted in early April because the Hungarian Plant Protection Service found nematode cysts in 13 wagons, mostly of Netherlands origin, and considered them to be *Heterodera rostochiensis*. For this reason, the Hungarian authorities regarded these imported potatoes as unfit for seed.

The seed potatoes shipped by the Netherlands originated from areas free from *Heterodera rostochiensis* and soil surveys for the nematode have been carried out annually. In view of the strict control enforced in the production of seed potatoes, the Netherlands authorities regarded it unlikely that the potato shipments could be infected. It was agreed consequently by both the Netherlands and Hungarian authorities that samples of potatoes and of nematode cysts be submitted to an expert for examination and identification. The Director-General of FAO accordingly requested Dr. Prosper Bovien of the Plant Pathology Institute, Lyngby, Denmark, well-known specialist in nematology, to give an independent opinion on the basis of potato samples taken by mutual agreement.

In the presence of the representatives of Hungary, the Netherlands and FAO, six potato samples together with soil were collected from five wagons, of which three samples were taken from the bags in which the Hungarian authorities had found nematode cysts. These samples were packed in paper bags to which were affixed the signatures of all the representatives participating in the sampling, stamped by the Hungarian Plant Protection Service, and lead-sealed by the railway authorities.

One set of these samples was kept by the Hungarian Plant Protection Service and another set was dispatched to Dr. Bovien by air freight from Vienna the next day. In addition, four nematode cysts collected and determined as *Heterodera rostochiensis* by the Hungarian scientists were also sent to Dr. Bovien.

After examining these samples, Dr. Bovien reported to the Director-General of FAO that no nematode cysts of any kind were found in the potato and soil samples contained in the sealed paper bags. He also reported that the four nematode cysts collected by Hungarian authorities do not belong to *Heterodera rostochiensis* but to a closely related species, possibly *H. schachtii*. Owing to the damaged condition of the cysts, he was unable to identify the species with certainty.

A small sample of these potatoes was also sent to the Austrian Plant Protection Institute, which reported that no nematode cysts were found in the sample.

In view of the dispute involved, the Government of the Netherlands suggested that the potato shipment be disposed in accordance with the decision of the International Committee of the Red Cross.

Roma - Tip. del Senato del dott. Giovanni Bardi